Productivity Improvement through Strategic Operational Layout in Composite Unit, India

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Abstract:
Strategic layout design involves a systematic physical arrangement of different departments, work stations, equipments, storage areas and common areas in a manufacturing industry. Nowadays in a competitive world, the strategic layout has an effective tool in cost reduction by improving the productivity. Also one of the most influential and most effective methodologies for eliminating wastes [MUDA], controlling quality, and improving overall performance of any system or process in any industry with the complete assurance of large annual profit margins. It has become very important to have a well organized plant layout for all the available resources in an appropriate manner to achieve the maximum output from the resources. To achieve the desired objectives a lot of methods and techniques are developed by many researchers in the domain area.

Key words:
Layout, Wastes, Productivity, Efficiency

Introduction:
To improve the effectiveness and efficiency of an organization, it is important to give a special attention to layout. Layout is an arrangement of different aspects of manufacturing in an appropriate manner to achieve desired production results. A small change in the arrangement of machines or equipments can improve the flow of materials and affect the overall efficiency of the manufacturing process. Strategic layout considers available space, final product, safety and facilities & convenience of operations. An effective strategic layout ensures that there is a smooth and steady flow of material, manpower and equipment at a minimum cost. Layout decides the best physical arrangement of all resources within the allocated space. Therefore, the main objective of the strategic layout planning is to design an effective workflow and improve productivity, also make equipments and workers more productive. The inability to get manufacturing process right cause to excess inventory, low quality product, unhappy customer, etc. Today’s manufacturing layout must be demonstrate adequate...
and flexible regardless of constant changes operating system. And this explains why layout is essential base of current industrial facilities and thereby enhancing the efficiency of product output and increase the productivity.

Need for layout decision:

- Inefficient operations
  1. High Cost
  2. Bottlenecks
- Changes in the design of products
- The introduction of new products
- Changes in volume of output
- Accidents
- Ambience

Inputs required for a strategic layout

- Marketing: demand forecast
- Product mix
- Production rate
- Mode of production: continuous/ intermittent
- Logistics: where to produce, capacity
- Aggregate production plan, how much
- Types and numbers of processes and equipments

Objectives of study:

A layout should be suitable to give an ideal relationship between raw material, equipment, manpower and final product at minimum cost under a safe and comfortable terrain. The aim of this work is to minimize workload and workers on the assembly line while meeting a required / maximum output. An efficient and effective layout can cover following objectives:

- The main objective of the layout is to increase the productivity.
- To provide optimum space to organize equipment and facilitate movement of goods and create a safe and comfortable work environment.
- To reduce the movement of workers, raw material and equipment.
- To promote safety of the plant as well as its workers.
- To facilitate extension or change in the layout to accommodate new product lines or technology upgradation.
- To increase capacity of the production of an organization.
- To identify the location of bottleneck and exclude them.
- To reduce the production cost.
- To minimize the total quantum of idle time and equally minimizing the number of operator to do a given amount of work at a given manufacturing line speed.
Different layout Scenarios:

Products variety and volume:

- **Fixed position layout:** It is also called as Static layout/Stationary layout. In this layout the movement of manpower and machines to the product remain stationary. Layout is ideal where the size of job is heavy and large and not applicable for small products or project. It is mainly used in the construction of bulky or fragile projects. Examples: ships, locomotives, aircraft.

- **Process layout:** It is also called as Flexible Flow or Job shop layout. All machines performing similar kind of operation are grouped together at one location. Mainly suitable to job and batch of production. This layout is more suitable for the industry where the products that are gotten from raw material and work in progress entails high variations while processing the individual operations. This layout is more useful in which the manufacturing process is in the batch form as the various products are organized to move from one area to another.

- **Product layout:** It is also called as Flow line layout. The machines and equipments are arranged in one line depending upon the sequence of operation required for the product. It's used for systems with high product volumes and a low variety of products. Product layout has a small cycle of manufacturing which reduce the material handling. In this layout machines and accoutrements are grouped together and thereby enabling supplies to flow material consecutively in a clear and easy to control manner from one point to another as values are being added on them.

- **Cellular layout:** In a cellular layout, machines are grouped into cells, to process families of similar parts. These cells also need to be placed on the organization’s shop floor. Thus, one is also generally concerned with so-called intra-cell machine layout problems. In this layout machines and equipment are arranged in order to enhance the steady and uninterrupted movement of materials and tools through the process of production without stoppage and time wastage.

Productivity generally defined as the ratio of an output to the unit of all of the resources used to produce this output. Productivity usually deviates from production. Production concerns an increment in output over a given span of time; productivity is concerned with the ratio of output to an input. Putting in another way, improving productivity has to do with how effectively people combine different resources to manufacture parts and services. With the correct choices, improved production, higher values and elevated incomes can be accomplished for every hour worked.

Layout standardization is a basic requirement of Lean management. If layout gets lean, productivity improves directly in terms of cycle time reduction and reducing non value adding work.

Tasks are to be assigned to workstations in Manufacturing line, so that the predetermined goal is achieved. Minimize of the number of workstations and maximize of the production rate are the most common pretension. Nowadays the actual case of different components manufactured at industries in which productivity improvement is a prime concern; minimize the total production cost and number of non value added work.
Equation used to calculate productivity

Productivity = Output/Input

Where, Input = Labor \* Production time per day (hour)

Equation used to calculate cycle time

Cycle time = Production time per day/ Unit required per day

Take a composite part as an example and see the process flow diagram and to analyze the process timing before and after applying the strategic process layout which are shown below.
Before applying the strategic process layout

Productivity = Output / Labor * Time

= 2.5 / 35X10

= 0.00714 pc/labor * time

After applying the strategic process layout

Productivity = Output / Labor * Time

= 3 / 35X10

= 0.0085 pc/labor * time

Before applying the layout the output of the product per day is 2.5 pcs, and after applying the process layout the output of the product per day is 3 pcs.

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Manufacturing Operation</th>
<th>Manpower/Pc</th>
<th>Before Time[Min]</th>
<th>Before Time[Min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mould Surface Clean</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Apply coats of release agent</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Surface preparation for gel coat</td>
<td>1</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Gel coat application</td>
<td>2</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>Wait till gel coat tacky</td>
<td>0</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Layup</td>
<td>3</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>7</td>
<td>Adding material</td>
<td>3</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>8</td>
<td>1st vacuum film sealing</td>
<td>3</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>9</td>
<td>1st vacuum check</td>
<td>3</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>Infusion</td>
<td>2</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>11</td>
<td>Cure the laminate for 4 hrs at room temp.</td>
<td>0</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>12</td>
<td>Aiding material removal</td>
<td>2</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>13</td>
<td>Product De-moulding</td>
<td>2</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>Product Surface inspection</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>15</td>
<td>Delay time</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Product trimming</td>
<td>2</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>17</td>
<td>Product Drilling</td>
<td>2</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>18</td>
<td>Product Preparation for Top Coat</td>
<td>2</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>19</td>
<td>Application of Top coat</td>
<td>2</td>
<td>120</td>
<td>110</td>
</tr>
<tr>
<td>20</td>
<td>Curing of Top coat</td>
<td>0</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>21</td>
<td>Identification Sticker Apply surface veil with resin coat on top of sticker</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>22</td>
<td>Delay time</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>23</td>
<td>QC dimension check</td>
<td>2</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>24</td>
<td>Buffing the product</td>
<td>2</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td>check gloss as per QAP</td>
<td>1</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>26</td>
<td>Final inspection</td>
<td>1</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Delay time</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Packing</td>
<td>3</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

| Total MHRS up to final product clearance | 1221 | 1195 |

Table 1.1
Literature Review:

Many researchers have been done in layouts. Effective strategic layout can reduce the operational costs of a company by 10-30%. Proper analysis of layout design could result in the improvement of the performance of production line. This can be done by optimizing the capacity of a bottleneck, minimizing material handling, reducing cycle time, effective utilization of labor, equipments and space. Strategic process layout is an overall approach concerned with the design, layout and incorporation of people, machines and activities of a system. Strategic layout design defines how to organize, locate and distribute the equipments and support activities in a manufacturing facility to accomplish minimization of overall production time, maximization of company’s output in conformance with production and strategic goals. A strategic layout can reduce or eliminate the waste [MUDA]. Layout problem has significant, major and long term impact on material handling inside the plant, total lead time of product to manufacture, work in progress and operating efficiency. A good placement of facilities contributes to the overall efficiency of operations and can reduce up to 50% the total operating expenses (Tompkins et al., 1996).

Research Methodology:

- Study of present methodology
- Collection of data of present methodology
- Analysis of data of present methodology
- Design of proposed methodology
- Collection of results of proposed methodology
- Comparison of present and proposed methodology
Before applying a strategic process layout:

After applying a strategic process layout:
Hypothesis:

A thesis test examines two mutually exclusive claims about a parameter to determine which is the most supported by the sample data. The parameter is generally the mean or proportion of some population variable of significance to the marketer. The null hypothesis \([H_0]\) is the status of the default position that there is no relationship or no difference. The alternative or research hypothesis \([H_A]\) is the opposite of null. It represents the relationship or difference. The conclusion of the hypothesis test can be correct or incorrect.

- \(H_0\): There is no significant difference between process layout and operations.
- \(H_1\): There is a significant difference between layout and productivity.

Advantages:

- Reduced overhead cost
- Increased utilization of equipments
- Encourages efficient supervision
- High products variety
- Enhanced flexibility
- Increase productivity
- It helps in bottleneck analysis
- It reduces set up time
- It reduces wastes (MUDA)
- Improvise 5S

Disadvantages:

- High work in progress inventory
- Low operations and precious material handling compared to the product layout
- Requires constant inspection
- High production gap
- Requires highly skilled operators

Constraints/Limitations:

- High space requirement. Space requirement is more compared to product layout.
- Longer production time.
- High production gap.
- It requires changes according to the process.

Conclusion:

From the above study, we can summarize that the strategic layout is very much important to improve productivity. And by this study, the organization can achieve the objectives like to provide optimum space to organize equipment, to promote order in production towards a single objective, to make a lean manufacturing process, etc.

This explains the need to have a good strategic operational layout design that will be able to switch from one point to another without major alterations. It will also achieve fast flow of raw materials and work in progress at the lowest cost and less material handling.
From the above table 1.1 we can see that the process layout helps to reduce the time. So that it can improve productivity with the good quality of the product. We can see that all the operations are arranged properly in line which is shown in the design of a strategic process layout.

From the above calculation we can see that because of layout the productivity is increased. Before applying the layout the product made in a day was 2.5 and after applying the layout the product made in a day is 3.

So, it is very important to apply a layout in industry.

Reference


